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ABSTRACT

A discussion of computer-assisted language learning focuses on management of individual learning processes. As distinct from a reference package, a computer-assisted teaching program has to assure that the student acquires and retains the complete information in the most efficient way, provide accurate and useful material, and pique the student's curiosity. One way to arouse student interest is to design multiple links of topics to allow for learner-centered discovery learning. An automatic guidance is needed to manage the learning process. This guidance can appear in two ways. Informational guidance is activated by the learner, presenting the status of learning to help the user make intelligent decisions about what to do next. Proactive or interventional guidance can interrupt the user when he attempts inappropriate steps in the learning process. In language teaching, writing a guidance that considers optimal repetition intervals, especially in a drill section, is a challenging task. It is proposed that in computer-assisted language learning, such guidance be implemented as an event filter. Contains 44 references in English and Chinese. (Author/MSE)

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College of Liberal Arts and Sciences

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Chin-Chuan Cheng

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LANGUAGE LEARNING LABORATORY
College of Liberal Arts and Sciences
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Technical Report No. LLL-T-24-95

Proactive Guidance in Computer-Assisted Language Learning

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Abstract

This paper focuses on managements of individual learning processes in computer-asssisted language learning. As distinct from a reference package, a computer-assisted teaching program has to make sure that the student acquires and retains the complete information in the most efficient way, in addition to providing accurate and useful material. It also needs to pique the curiosity of the student. One way to arouse the user's interest is to design multiple links of topics to allow for learner-centered discovery learning. An automatic guidance is needed to manage the learning process. The guidance can appear in two ways. The informational guidance is activated by the user. It presents the status of learning to help the user make intelligent decisions as to what to do next. The proactive or interventional guidance can interrupt the user when he attempts to do things that are not appropriate to his learning process. In language teaching a challenging task is to write a guidance that considers optimal repetition intervals to determine when is the best time to repeat a lesson, especially a drill section, to retain language automaticity. It is proposed that guidance be implemented as an event filter.

1. Automatic Guidance

Nowadays computers are ubiquitous. And the industry has produced a great number of reference software packages such as *Encarta* (Microsoft 1993-94) and *Talking Dictionary* (Softkey 1994). The speed of such production makes language professionals envious. However, compiling a reference package for the user to browse or to search for specific items is different from writing a computer-assisted teaching program. A reference software package has to ensure that the information provided is accurate and that the user can quickly find items of interest. A teaching program, on the other hand, has to make sure that the student acquires and retains the complete information in the most efficient way, in addition to providing accurate and useful material. Efficacy is a matter of pedagogy. As language teachers we are predominantly concerned with how to guide the student in the course of study. In other words, the courseware we develop should act like a good language teacher. Over the years we have compiled a number of lessons and thus have gained some experience in material development. Now it is time to readjust our focus from material assembly to implementation of guidance to help the student learn the material. I will quickly review what we have done in computer-assisted Chinese language learning in the past as background information and then return to guidance issues as my main topics.

In the early 1970s the research and application of computer-assisted instruction were gathering momentum at the University of Illinois. We compiled scores of software lessons for teaching beginning Chinese (Cheng 1973, Chen and Cheng 1976, Cheng 1977). In the

middle 1980s as personal computers were increasingly available to humanists, several attempts were made to harness the PC for language instruction (Yao and Peterson 1986, Baxter 1986, Li and Cheng 1987). The incorporation of multimedia allowed us to combine texts, sound, and images in lesson presentation (Mowry and Yao 1990, Cheng 1991, Zhang and Xiang 1991, Zheng 1991, Mowry 1993, Dartmouth College 1990-1993, Yan 1990). In the past few years as computers became more readily available for instructional use, more lessons were created (Huang 1990, Li 1993, Liu 1993a, Yan 1993, Sun et al. 1993, Zheng 1994).

Some of these lessons present language materials such as animated stroke sequence of character writing, reading passages with vocabulary help, and informational signs at public locations. Many others provide exercises and drills for the student to learn new words and sentence patterns. The topics in these lessons are mostly organized linearly, allowing the user to move from one subject to another in a specific order. The sequence reflects the author's pedagogy. Almost all these lessons give diagnostic messages in judging the student's response.

Besides these teaching materials, we find writings dealing with issues of general interest. In the early 1980s we discussed how to use an analog-digital converter to judge the student's pronunciation of the four tones in Standard Chinese (Cheng and Sherwood 1981, 1982). As personal computers came into popular use, we proposed a design of an authoring system with Chinese-character and lexical databases, object manipulation, computer-author interaction, record keeping, and error analysis (Cheng 1986a, 1986b, 1990). During that time computers were perceived by some people as excellent devices on which to do exercises and drills (Wang 1986, Zheng 1991, 1993). Other possibilities such as incorporation of database, natural language analysis, information processing, and electronic dictionaries were also proposed for computer-assisted Chinese learning (Qiu and Xu 1986, Chu 1990, Hsieh 1990, Zhang 1991, Zhang and Xiang 1991). It is natural to see studies in pedagogical issues presented in conferences in recent years (He 1991, Yu 1992, Liu 1993b).

The central concern of these teaching materials and discussions is how to develop good lessons and how to manage efficient learning. Learning management has actually been implemented in several ways. Answer judging is a type of management, telling the user what went wrong in his response to a particular question item. Moreover, the overall organization of a lesson, the sequence of study, the linking of topics, etc. represent the author's view of how to best study the subject. However, this type of management generally does not treat an individual's learning process. It is perhaps best called lesson organization.

Other treatments of learning process are subsumed under "course management" and "help". Course management usually consists of enrollment "roster" for sign-on, "sign-on record" to keep the individual's learning history, "lesson routing" to direct the learner to appropriate sections to start or to resume study, and "gradebook" to record individual performance. Help is familiar to all as we often use it on the menu bar. It provides

information on the courseware and gives general as well as contextual assistance to the user. What is missing in the management is the component that acts like a good teacher to advise individual learners what to do when they need guidance and to intervene in the learning process when they attempt to go about learning in an inefficient way. As will be discussed below, advisement can include informational guidance and proactive or interventional guidance (Cheng 1993). Thus learning management systems can be outlined as follows:

Learning management systems
- Course management
  - Enrollment roster
  - Lesson routing
  - Sign-on record keeping
  - Gradebook
- Help on topics and direction
  - Information on contents
  - General lesson direction
  - Contextual help
- Answer judging
  - Error analysis
- Advisement -- management of individual learning process
  - Informational guidance
  - Proactive guidance

We will set our focus on advisement. In the past, course management systems were not fully utilized to make useful management of an individual's learning process. We propose to have two types of guidance built in the courseware. The informational guidance needs to provide advisement to let the user know his status of learning, and the proactive guidance interrupts the user when he jumps to an inappropriate section or attempts to terminate the study before completing an information chunk.

If a lesson is arranged linearly, compelling all the students to start from the same point, go through equal number of topics, take identical quizzes, and terminate in the same section, then there is no need to manage individual learning process. However, such a lesson ignores the differences in individual ability and learning style, and therefore can be uninteresting to many users. A remedy is to organize the subjects in such a way that the user can branch to matters of interest anytime, thus making multiple linking of topics for discovery or exploratory learning. However, in an exploratory learning environment, the user may not be able to understand the organization of the knowledge or may become lost. At this juncture a good teacher would guide the student to the proper place. A good lesson also should lead the learner to navigate through the links for efficient learning. We will discuss an exploratory learning environment to show the need for guidance.

2. Exploratory Learning

Some years ago, we constructed a program on the IBM PC platform to teach Chinese informational signs that tourists in China normally encounter in hotels, airports, and other locations (Cheng 1991, Li and Cheng 1987). For each location we present about a dozen informational signs. To take the airport location as an example, the signs included are the following:

入境	Rùjìng	Entry
到达	Dàodá	Arrival
男	Nán	Men
女	Nǚ	Women
取行李处	Qǔ Xíngǐ Chù	Luggage claim
护照检查	Hùzhào Jiǎnchá	Passport Inspection
海关检查	Hǎiguān Jiǎnchá	Customs Inspection
厕所	Cèsuǒ	Toilet
银行	Yínháng	Bank
出租汽车	Chūzū Qìchē	Taxi
服务台	Fúwùtái	Service Desk
出口	Chūkǒu	Exit

These signs are displayed in Chinese characters, Pinyin, and English. Instructions on the screen tell the student that it is not necessary to memorize the Chinese words and that another chance for studying them will be given later. The instructions also explain certain designated function keys as toggle keys, which can be used to hide and display Pinyin, English, and Chinese characters as the user attempts to recall the pronunciations, meanings, and characters. Another section teaches the writing of the script. In addition, there are two sections that test the learner's ability to recognize these signs. In the initial section the sole activity on the part of the learner is hide and display the phrases for self test. As we can see here, this section of the lesson is entirely passive. It will take a highly motivated student to stare at the signs and somehow try to remember their shapes and meanings. For those who have grown up playing video games, such a lesson would not readily pique their curiosity. Without curiosity there will not be much learning. During the early days of the development of computer-assisted instruction, many people thought that the computer was tireless and therefore was an ideal tool to do uninteresting but necessary drills so as to allow the instructor to do more interesting things in class. The drills quickly killed the interest of the student.

There are many ways to arouse the interest of the student. Mowry and Yao (1990)'s program *Mr. Wang and Miss Li* teaches some Chinese action verbs. They use the activities of dressing and undressing to show the meanings and usage of about 60 words. In some sections the animated figures progressively undress to refined nudity. It is interesting to see how to do things with words.

For our informational signs program a way to arouse curiosity is to allow the user to explore the signs in depth. For example, the word *yínháng* 'bank' in our lesson can be explored in the following way. Once the user selects it for exploration, the screen can show the video image of a bank building. What's inside? The multimedia and pointing devices will allow the student to virtually enter the bank. What are the exchange rates? There can be a sign board posting rates in Chinese. What are these currencies? The names of currency of various countries can be learned there. What does a Chinese bill look like? He can change money with a bank teller. Upon receiving Renminbi he tries to read the words and numbers. What are the denominations? Cent? Ten cents? Twenty-cent bill? Yuan? Further examining the bill he finds several language scripts printed on its face. Arabic in China? He can point at the languages for explanation of the writings of Arabic, Zhuang, Chinese, etc. From there he is given an opportunity to study the language affinities and customs of the 56 ethnic groups in China. Such a program has many links for the topics. This is a hypertext design.

It is fun to explore various things. Multimedia also give authentic language contexts. However, as the student started with the word *yínháng* 'bank' and went through various matters, did he learn much and did he remember why he got to where he was? What was the purpose of examining the ethnic minorities? What to do next? In a multiple linking, discovery learning environment, it is easy for the learner to become lost. The student may be lost in navigation. More seriously he may not be able to see the organization of the knowledge. Cognitive overload and disorientation are common problems. It is useful to give the student a study map, so to speak, to help him understand what he has done and to guide him to return to the focal point of study.

HyperCard (Apple 1990), ToolBook (Asymetrix 1994), and some reference packages indeed can display the individual's navigation history. A navigation recorder keeps a journal of sections visited. It appears only when the user requests for navigation assistance. It can therefore be called passive guidance. The informational guidance we have in mind is similar to the navigator. The difference is that our guidance takes into consideration not only the topics visited but also the information stored in the course management system including lesson routing, sign-on records, and performance characteristics as can be obtained from the gradebook. The guidance will have to make a synthesis of what the student has done and to make an intelligent judgment of what the student should study next. The information given to the learner can include a suggestion of what to do at this juncture.

How we guide the student to successfully learn the material is the central issue here. The informational guidance just discussed is activated by the student. Guidance in general can be considered as a matter of control of the learning process. And in some cases the guidance needs to be more forceful so as to intervene in the learner's inefficient attempts. This type of advisement may be called interventional or proactive guidance.

3. Proactive Guidance

Many teaching programs were driven by linear thoughts. In a linear teaching program, the author controls the sequence of presentation and therefore imposes one learning style on all students. As we discussed earlier, a hypertext, multiple-linking system, on the other hand, gives much freedom to the user to take various routes to discover the knowledge. Just as a good teacher usually explains things from different angles instead of repeating the same definition, a multifaceted or multidimensional discussion of a word, subject, or topic usually gives the learner a fuller understanding of the matter. As such presentation relates various matters, it also helps to apply knowledge to new cases. The multifaceted learning here or random access instruction in Spiro and Jehng (1990), in my view, arouses curiosity, provides environments for discovery learning, affords cognitive flexibility, and facilitates knowledge transfer.

Hypertext provides linking of various materials and items, and thus makes it possible to have learner-centered discovery learning. Current technologies allow us to compile all sorts of teaching materials fairly quickly. The use of motion video, images, text, graphics, and digitized speech makes a computer-assisted lesson very rich in content indeed. But a package for the user to explore without any guidance cannot be called a teaching program. In a multiple linking environment the user may not be able to understand the structure or the hierarchical organization of the knowledge. The user may jump to another topic without properly completing an information chunk, thus losing the opportunity for integration and synthesis. We therefore feel that at some crucial point linear sequencing of teaching material is needed.

We will use one of our own programs to illustrate the linearity requirement. We have implemented a character-writing program to explain both the basic strokes and the rules for writing (Chao and Cheng 1989, Chao 1991). For ease of discussion here, the rules of stroke sequence are simplified and are given in traditional terms as follows:

1. From top to bottom
2. From left to right .
3. Horizontal precedes vertical
4. From outside to inside
5. Left slanting precedes right slanting
6. Inside precedes the sealing stroke
7. Middle precedes the two sides

It seems that explanations for each rule will make an appropriate unit for study. A unit contains an integral chunk of information. The units can be studied individually. But if the user is studying them for the first time, jumping into any place other than the unit for the first rule would not help to gain an integral understanding of the Chinese stroke-writing sequence. Therefore for the user making the initial study we may wish to strictly enforce the linear sequence and insist that each unit be completed in one sitting. Naturally, a user who has gone through these units will be allowed to browse any part at any time.

Thus we wish to enforce linear study for beginners and to allow random access for others. The lesson will have to be organized to make random access possible. Then the linear sequence of study will be enforced by the automatic guidance.

To intervene in the student's learning process, the guidance will need to consult the individual's learning history. Record keeping in detail for sign-on time, study duration, sections visited, test scores, etc. is a standard facility on large scale computer-assisted instructional systems such as PLATO or NovaNet. On personal computers, authoring systems should provide such a function. Currently popular authoring systems such as HyperCard and ToolBook do not provide record-keeping functions. The author will have to take care of these details. Once we have the user's learning history, we can determine whether random browsing for certain units, such as the those teaching stroke order rules given above, is allowed or not.

When we demand that an entire unit be completed in one sitting, we are making a statement that the unit is one information chunk. Starting a chunk without completing it would not get the sense of what is intended. Therefore linear teaching in a multiple linking environment requires an automatic guidance to advise the user to stay with the topic until completion. This implies that the guidance is proactive, intervening in the user's activity at a crucial point of the learning process.

Thus computer-assisted teaching programs should keep a good balance of linear progression and multiple-linking to help the learner understand the topic. Earlier, multiple-linking was predicated by the need to satisfy curiosity and by the presentation of multifaceted view of matters. To facilitate multifaceted learning in a multiple-linking environment we would implement a guidance to direct the user to various places so as to view a topic from different angles. But directing the user to jump back and forth among related topics might interfere with learning. The interventional nature of proactive guidance should be treated with care. In some cases, multifaceted learning does not have to be implemented with multiple linking. The teaching lesson can assemble related items in one place for study. For example, in our signs lesson, some individual characters of a sign may also be used in other phrases. If these related words are also displayed on the same screen, the user will have a fuller understanding of the meanings and usage of the characters. After all, a character may occur in many phrases. We can bring the associated words to one place for the user to learn the semantic network. For example, the word 人 in 人境 also occurs in the other lessons of the same signs program. As the associated words are assembled here the user does not have to take other routes to reach them to see various uses of the word 人.

入境	Rùjìng	Entry	
入	Rù	Enter	
入口	出口	出入请下车	地铁出入口
Rùkǒu	Chūkǒu	Chūrù Qǐng Xiàchē	Dìtiě Chūrùkǒu
Entrance	Exit	Please Alight as You Enter or Leave the Gate	Subway Entrance

Miller and Gildea (in Wang 1991) state that children acquire words by observing how they are used in intelligible contexts and that multiple encounters are required to learn them. By presenting related words on one screen we hope to facilitate learning and to avoid interruptive behavior of proactive guidance.

In order to evaluate the learner's choice for study, our proactive guidance will have to be implemented as a filter in an object and message passing hierarchy. In this way, the guidance can evaluate the learner's move before the activity is carried out. For example, the screen may display the objects of stroke-writing rules discussed above. When the user clicks rule 4, the guidance receives the event message first. It looks up the student's learning history to make a decision. If the student has studied rules 1 , 2, and 3, then the guidance would not interfere. If the student has not visited the object of rule 1, then it will appear on the screen to explain the rule relations and either strongly advise the learner to do rule 1 first or simply take him to rule 1.

So far we have discussed language learning as a process of knowledge acquisition. However, one important difference between learning a language and learning linguistic analysis is the formation of automaticity. To speak a language, one utilizes elements and structures them in an automatic way. Therefore computer-assisted language lessons have to allow the user to gain automaticity. Traditionally, drill with relentless repetition helps the learner to do things with words without thinking about the structures and rules, and therefore is a way to gain automaticity. In practice, once a drill starts, it is blind to what has already become automatic. If the student can use a word automatically, there is no need to repeat the drill. If the word is forgotten entirely, a rapid-fire drill will not go smoothly. Therefore the crucial question is: how does a lesson arrange the repetition spacing properly so as to let the learner repeat just at the point of loosing automaticity? This is a decision to be made by the automatic guidance.

Since many of our lessons contain drills. We need to recognize the importance of the guidance that manages the drill intervals. Wozniak (1993) has presented a formula for calculating the optimal repetition intervals in knowledge acquisition. An optimal interval is the interval that results in a small fraction of knowledge being forgotten. It is a difficult challenge to language teachers to establish a repetition spacing for gaining language automaticity. Explorations in this area will raise many important pedagogical questions.

Another challenging task for both language teachers and computer scientists is the systematic implementation of guidance. While guidance in various forms have appeared in

computer-assisted teaching lessons, an integration of guidance and various objects is yet to be achieved. We will present our implementation of guidance as an event filter below.

4. Implementation of Guidance

Nowadays computer processing is often viewed as some events occurring in some objects. Let us discuss the implementation of guidance in the context of object-oriented, event-driven authoring systems. ToolBook, for example, allows the author to organize the lesson material in a hierarchical structure starting at the lowest level with hotwords in text fields, buttons, graphics and pictures, and stages for motion video. These objects form a page. Pages may share a common background. A book then consists of the pages and backgrounds. The objects are organized in a hierarchy such as that given in Figure 1. The input from the keyboard, the pointing device, and possibly voice are events that drive the objects. To relate events and objects, one can write a script for each object to handle events. For example, the user can click on a button. The script of the button receives the button click message and causes the screen to display the information from another page. If the event is not handled at a lower hierarchy, then it is automatically forwarded to the objects at the higher levels.

In such an organization of objects, guidance can be implemented as a filter for the objects that are driven by events. As an event occurs in an object, guidance acts like a filter to intercept the message, examines it, consults the student's record and the lesson structure to decide whether to forward the message to the object without intervention or to advise the student in some appropriate way. The informational guidance can be activated by the user as discussed before. The proactive guidance is automatically activated by events that concern the learning process. We propose that the guidance filter be added to all the circled objects in Figure 1.

There are many details to be worked out to make the compilation of guidance as intuitive as possible. Furthermore the actual programming may take a different form than as presented here. However, we hope that the concept of event filter is a useful one for research in guidance.

In the process of examining the activities of Chinese lessons and in particular of our own software, we saw the needs of software guidance to distinguish teaching programs from reference packages. Since the appearance of HyperCard, many Chinese language teachers have been able to assemble multimedia materials for learning. In this paper we suggest that pedagogical issues be seriously considered as we compile a lesson. Now we will summarize the points discussed above.

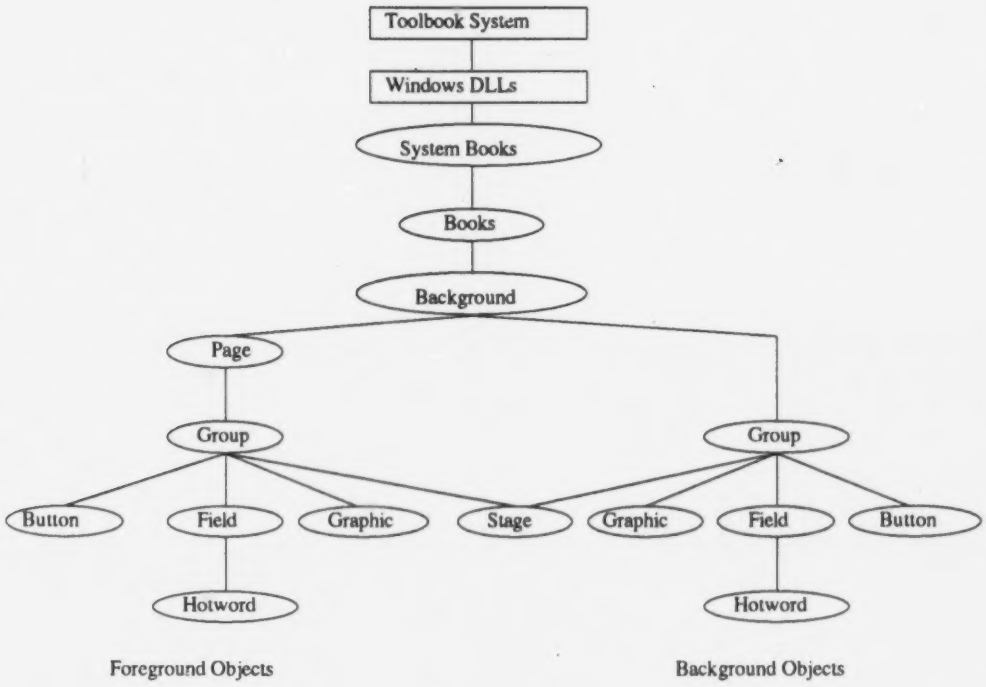

Figure 1. Guidance as event filter for circled objects

5. Conclusion

We feel that a teaching program has to pique the curiosity of the student. One way to arouse the user's interest is to design multiple links of topics to allow for learner-centered discovery learning. An automatic guidance is needed to manage the learning process. The guidance can appear in two ways. The informational guidance is activated by the user. It presents the status of learning to help the user make intelligent decisions as to what to do next. The proactive or interventional guidance can interrupt the user when he attempts to do things that are not appropriate to his learning process. In language teaching a challenging task is to write a guidance that considers optimal repetition intervals to determine when is the best time to repeat a lesson, especially a drill section, to retain language automaticity. We further propose that guidance be systematically implemented as an event filter in an object-oriented, event-driven system.

Naturally, in computer-assisted language learning there are other issues involved, such as course contents, supplementary or independent nature of programs, character input for beginning students, answer judging, etc. However, the discussion here can be interpreted as a search for a principled way of evaluating Chinese teaching software. It is hoped that in the future all lesson authors will be able to say that they construct their

lessons not because the computer is there but because they have a pedagogical statement to make.

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